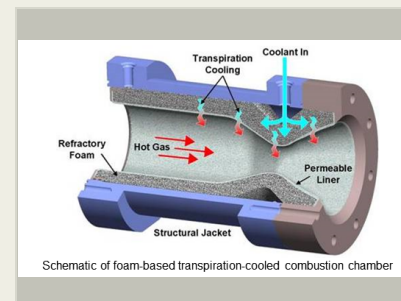


Low-Cost, Lightweight Transpiration-Cooled LOX/CH₄ Engine, Phase I

Completed Technology Project (2015 - 2015)

Project Introduction

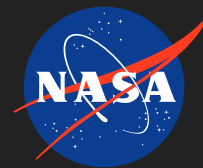
The specific impulse of a rocket engine increases as the chamber pressure increases, but so does the heat flux to the chamber wall. Ultimately, this defines the maximum operating pressure for the engine. For regeneratively cooled engines, even those using film cooling, the practical limit has been reached, and further increases in chamber pressure are simply not possible. Transpiration cooling does not have this limitation. Furthermore, because a transpiration-cooled engine pumps only a tiny fraction of the fuel through the wall, a smaller and hence lighter pump can be used, which will significantly reduce the dry mass. Finally, because transpiration cooling can keep the wall much cooler than regenerative cooling with film cooling, a transpiration-cooled engine can use less refractory (i.e., lighter weight) materials, thereby achieving additional reductions in dry mass. The net results are significant increases in the thrust-to-weight ratio and specific impulse and a significant decrease in the dry mass of the system. The perceived limitation of transpiration cooling with a porous wall is coking and blockage of the pores if a carbon-based fuel such as methane is used. In previous work using LOX/H₂ propellant, Ultramet showed that with minimal transpiration flow, the wall temperature can be kept well below the point at which methane would form coke. In this project, Ultramet will work with Purdue University to build on previous success with transpiration cooling in LOX/H₂ engines and design a lightweight LOX/LCH₄ engine in the 10,000- to 25,000-lbf thrust range. The transpiration model will be physics-based and applicable to both LOX/LCH₄ and LOX/H₂. Key component demonstrators will be fabricated and used to collect empirical data on the thermal, structural, and hydraulic characteristics of the wall architecture. Transpiration rates on subscale hardware will be verified through flow testing, and empirical data will be used to verify the predicted lack of coking.



Low-Cost, Lightweight Transpiration-Cooled LOX/CH₄ Engine, Phase I

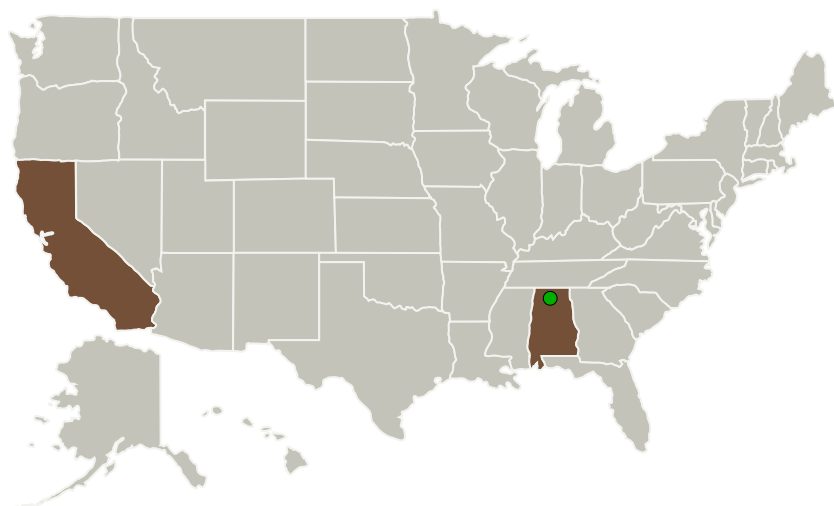
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Low-Cost, Lightweight Transpiration-Cooled LOX/CH₄ Engine, Phase I

Completed Technology Project (2015 - 2015)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ultramet	Lead Organization	Industry	Pacoima, California
● Marshall Space Flight Center (MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations

Alabama	California
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Project Transitions

▶ **June 2015:** Project Start

✓ **December 2015:** Closed out

Closeout Summary: Low-Cost, Lightweight Transpiration-Cooled LOX/CH₄ Engine, Phase I Project Image

Closeout Documentation:

- Final Summary Chart Image(<https://techport.nasa.gov/file/139185>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Ultramet

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

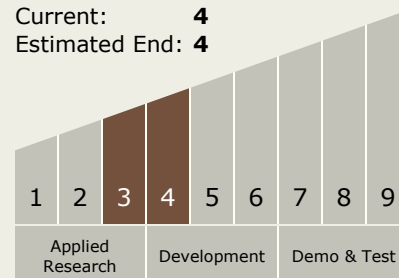
Carlos Torrez

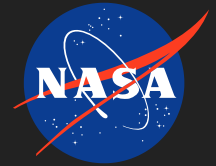
Principal Investigator:

Arthur J Fortini

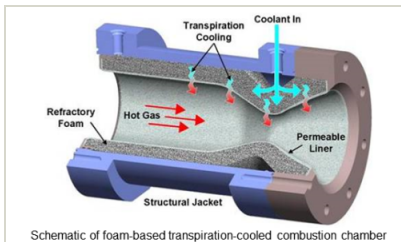
Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**





Images



Briefing Chart Image

Low-Cost, Lightweight
Transpiration-Cooled LOX/CH₄
Engine, Phase I

(<https://techport.nasa.gov/image/129092>)

Technology Areas

Primary:

- TX01 Propulsion Systems
 - └ TX01.1 Chemical Space Propulsion
 - └ TX01.1.3 Cryogenic

Target Destinations

The Sun, Earth, The Moon,
Mars, Others Inside the Solar
System, Outside the Solar
System